

3/pets

MACHINE FOR TENDING ELECTROLYTIC CELLS USED FOR THE  
PRODUCTION OF ALUMINIUM

Field of the invention

The invention relates to production of aluminium by fused bath electrolysis according to the Hall-Héroult process. In particular, it relates to pot tending machines on travelling cranes used in plants  
5 for the production of aluminium.

State of the art

Aluminium metal is produced industrially by fused bath electrolysis, namely by electrolysis of alumina in  
10 solution in a molten cryolite bath called an electrolyte bath using the well-known Hall-Héroult process. The electrolyte bath is contained in pots called "electrolytic pots" comprising a steel shell lined on the inside by refractory and/or insulating  
15 materials, and a cathode assembly at the bottom of the pot. Anodes made from a material containing carbon are partially immersed in the electrolyte bath. The assembly formed by an electrolytic pot, its anodes and the electrolyte bath is called an electrolytic cell.

20 Plants contain a large number of electrolytic cells arranged in line in buildings called electrolysis halls or rooms and electrically connected in series using connecting conductors so as to optimise the floor occupancy of the plants. The cells are usually  
25 arranged so as to form two or several parallel lines

that are electrically connected to each other by end conductors. The electrolytic current thus passes in cascade from one cell to the next.

During operation, an electrolysis plant requires  
5 action on electrolytic cells particularly including the replacement of spent anodes by new anodes, tapping of liquid metal from cells and drawing off or adding electrolyte. The most modern plants are equipped with one or several pot tending units to carry out this  
10 work, comprising a travelling crane that can be moved longitudinally above the electrolytic cells, and a pot tending module comprising a trolley and handling and working devices (often called "tools") such as shovels and pulley blocks, that can be moved on the travelling  
15 crane. These pot-tending units are often called Pot Tending Assemblies (PTA) or Pot Tending Machines (PTM).

However, movement capacities of known pot tending units are limited, particularly due to the electrical power supply cables that only allow limited linear  
20 movements or limited rotating movements.

Therefore, the applicant searched for pot tending units to avoid these disadvantages while remaining reliable.

## 25 Description of the invention

An object of the invention is a rotating mechanical and electrical connecting device between a transport module, typically a trolley, and handling and working devices in a fused bath electrolysis aluminium  
30 production plant, characterised in that it comprises a "fixed" frame fitted with a hub or straight shaft, a

sleeve surrounding the hub capable of rotating about the hub, first and second "rotating" frames capable of rotating about the sleeve, and sliding rotating electrical contacts between the frames and the drive systems to make the frames rotate with respect to each other about a common axis.

More precisely, the rotating mechanical and electrical connecting device according to the invention is characterised in that it comprises:

- 10       - a "fixed" frame comprising a hub or shaft called the "central" shaft defining a rotation axis,
- a sleeve surrounding the said hub and capable of rotating about the hub and about the said rotation axis,
- 15       - a first "rotating" frame rotating with the said sleeve and capable of rotating about the rotation axis,
- a second "rotating" frame capable of rotating about the said sleeve and the rotation axis,
- 20       - a first plurality of sliding rotating electrical contacts including one member that is designed for connections to external conductors and is fixed to the fixed frame and another member that is designed for connections to conductors in the system
- 25       that could be driven in rotation and is fixed to the sleeve,
- a second plurality of sliding rotating electrical contacts including one member that is fixed to the second rotating frame and another member that is
- 30       fixed to the sleeve, each member being designed for

connections to conductors in the system that could be driven in rotation,

- a first drive system capable of rotating the first rotating frame about the said rotation axis,
- 5        - a second drive system capable of rotating the second rotating frame about the said rotation axis.

Thus, the two rotating frames and the sleeve of the connecting device according to the invention are designed to rotate about a common rotation axis that is typically vertical in use, independently of each other. The rotation of the frames and the sleeve is then said to be "coaxial". The sleeve is driven in rotation by the first rotating frame, typically through a mechanical means such as a pin.

15        The connecting device according to the invention enables a rotation with no angular limit between the three frames, while making a permanent electrical link between them. The fact that the frames rotate independently increases the operator's comfort and efficiency.

20        The invention will be better understood after reading the detailed description given below of a preferred embodiment thereof and that is illustrated with reference to the attached figures.

25        Figure 1 illustrates a sectional view of a typical electrolysis room designed for aluminium production and comprising a pot-tending unit shown diagrammatically.

30        Figure 2 shows a diagrammatical side view of a pot-tending module of a plant for the production of aluminium by fused bath electrolysis according to the invention.

Figure 3 illustrates a sectional view of a connecting device according to the invention.

Electrolysis plants designed for the production of aluminium include a liquid aluminium production area that includes one or several electrolysis rooms (1). As shown in figure 1, each electrolysis room (1) comprises electrolytic cells (2) and at least one "pot tending unit" or "pot tending machine" (3). The electrolytic cells (2) are normally arranged in rows or lines (typically side by side or head to head), each row or line typically comprising more than one hundred cells. The said cells (2) comprise a series of anodes (21) provided with a metallic stem (22) that will be used for attachment and electrical connection of the anodes to a metallic anode frame (not shown).

The pot-tending unit (3) is used to carry out operations on cells (2) such as anode changes or filling of feed hoppers of the electrolytic cells with ground bath and with  $AlF_3$ . It can also be used for handling various loads such as pot elements, liquid metal ladles or anodes.

The pot-tending unit (3) comprises a travelling crane (4) that can be longitudinally moved above the electrolytic cells (2), and a pot tending module (5) comprising a mobile trolley (6) that can be moved on the travelling crane (4) and several handling and working devices (7, 8, 9, 10, 11), such as tools (shovels, wrenches, crust breakers, etc.) and control cabs.

The travelling crane (4) is supported on and travels along crane rails (30, 30') arranged parallel

to each other and to the main axis of the hall (and the line of cells). The travelling crane (4) can thus be moved along the electrolysis room (1).

According to the invention, the rotating  
5 mechanical and electrical connecting device (100) between a transport module, typically a trolley (6) and handling and working devices (7, 8, 9, 10, 11) in a fused bath electrolysis aluminium production plant is characterised in that it comprises:

10 - a "fixed" frame (101) designed to be fixed to the said transport module (6) and comprising a hub (102) defining a rotation axis (103), which is typically perpendicular to the main plane of the said fixed frame;

15 - a sleeve (121) surrounding the said hub (102) and capable of rotating about the said hub (102) and about the said rotation axis (103),

- a first "rotating" frame (110) capable of rotating about the said rotation axis (103) and driving  
20 the said sleeve (121) in rotation, and designed to carry at least one handling and working device (7, 8, 9, 10, 11);

- a second "rotating" frame (120) capable of rotating about the said sleeve (121) and the said  
25 rotation axis (103), and designed to carry at least one handling and working device (7, 8, 9, 10, 11);

- at least a first plurality of sliding and rotating electrical contacts (113) each comprising at least one first member (1131) fixed to the fixed frame  
30 (101) and connected to at least one external conductor (117), and at least one second member (1132) fixed to

the sleeve (121) and connected to at least one distribution conductor (118, 1181, 1182);

- a second plurality of sliding and rotating electrical contacts (114) each comprising at least one  
5 first member (1141) fixed to the second rotating frame (120) and connected to at least one distribution conductor (119), and at least one second member (1142) fixed to the sleeve (121) and connected to at least one distribution conductor (1181, 1182);

10 - a first drive system (140, 141, 142) capable of rotating the first rotating frame (110) about the said axis (103);

- a second drive system (150, 151, 152) capable of rotating the second rotating frame (120) about the  
15 said axis (103).

The hub (102) is blocked in rotation with respect to the fixed frame (101). During use, the fixed frame (101) is typically above the rotating frames (110, 120). The rotation axis (103) is normally substantially  
20 vertical.

The first rotating frame (110) rotates with the sleeve (121) and typically drives it in rotation by a mechanical means (123) such as a pin.

The said pluralities of sliding and rotating  
25 electrical contacts (113, 114) typically comprise rings or tracks fixed to the sleeve (121) and brushes or slippers fixed to the frames (101, 120). There are typically a few or several tens of rotating and sliding electrical contacts. In particular, they may be used  
30 to transfer control signals and electrical power. The said pluralities of electrical contacts (113, 114) are

advantageously protected by a casing (115, 116). The frames (101, 110, 120) typically comprise openings through which the said external and distribution conductors can pass.

5       The external conductors (117) are normally fixed with respect to the fixed frame. The distribution conductors (118, 1181, 1182, 119) are electrical conductors of the connecting device that can be driven by rotation of the rotating frames (110, 120). The  
10       distribution conductors comprise a first series of conductors (118, 1181, 1182) that are normally fixed with respect to the sleeve (121) and to the first rotating frame (110), and a second series of conductors (119) that are normally fixed with respect to the  
15       second rotating frame (120).

In one advantageous embodiment of the invention, the connecting device (100) also comprises:

- a first annular bearing (111) between the fixed frame (101) and the first rotating frame (110)  
20       enabling rotation between these two frames about the rotation axis (103);

- a second annular bearing (112) between the first rotating frame (110) and the second rotating frame (120) enabling rotation between these two frames  
25       about the rotation axis (103).

The annular bearings (111, 112) are typically roller bearings, such as rings with roller bearings.

The connecting device (100) according to the invention advantageously comprises one or more assembly  
30       means of holding the said frames (101, 110, 120) in a given axial position. These assembly means may be



fully or partly integrated into the annular bearings (111, 112).

The drive systems (140, 141, 142, 150, 151, 152) typically comprise a motor (140, 150), a gear (141, 151) and a toothed ring (142) or a toothed wheel (152). The motor (140, 150) and the ring (142, 152) may be fixed to the fixed frame (101) and to one of the rotating frames (110, 120) respectively, or vice versa. The motor (140, 150) may be fixed to the rotating frame or the fixed frame by a mechanical means such as an arm (153).

According to another possible variant of the invention, the drive systems (140, 141, 142, 150, 151, 152) may comprise one or more drive wheels based on surface grip and at least one track.

The connecting device (100) advantageously comprises complementary annular bearings (160, 161, 162, 163, 164) between the sleeve (121) and the fixed frame (101), possibly through the hub (102) - as illustrated in figure 3 - and/or complementary annular bearings (170, 171) between the sleeve (121) and the second rotating frame (120). These complementary bearings avoid lateral displacements of the rotating elements (110, 120, 121).

According to one advantageous variant of the invention, the connecting device also comprises rotating pneumatic and/or hydraulic connecting means (130, 131, 132, 133) between the fixed frame (101) and at least one of the rotating frames (110, 120), and preferably both, and therefore for at least one of the turrets. In particular, these connecting means enable

a compressed air supply to the handling and working devices. These means advantageously comprise an axial cavity (130) in the central shaft (102), sealed rotating joints (131, 132) and complementary conduits  
5 (133, 134).

In one preferred embodiment of the invention illustrated in figure 3, the first rotating frame (110) is located between the fixed frame (101) and the second rotating frame (120). In this embodiment of the  
10 invention, the drive system of the second rotating frame (120) preferably comprises a toothed wheel (152) fixed to the hub (102) and a motor (150) fixed to the second rotating frame (120) and fitted with a gear (151).

15 Another object of the invention is a pot tending module (5) for use in a fused bath electrolysis aluminium production plant and comprising a trolley (6) and handling and working devices (7, 8, 9, 10, 11), characterised in that it also comprises:

20 - a connecting device (100) according to the invention, linked to the said trolley (6) through the said fixed frame (101);

- a first turret (110') formed by the said first rotating frame (110) or linked to the said first  
25 rotating frame (110) and comprising at least one first handling and working device (7, 8, 9, 10, 11);

- a second turret (120') formed by the said second rotating frame (120) or linked to the said second rotating frame (120), and comprising at least  
30 one second handling and working device (7, 8, 9, 10, 11).

For example, the first turret (110') typically comprises a control cab (11) and a hopper (10) containing the anode cover product. The second turret (120') typically contains the various pot tending tools for electrolytic cells, such as a crust breaking device (8) that will break the alumina and cryolite crust that forms about and between the anodes, a shovel (7) for removal of solid elements contained in an electrolytic cell at the time of an anode change and a system for handling anodes (9) designed for extraction of spent anodes and for the placement of new anodes.

The connecting device (100) is then typically placed so that the rotating frames (110, 120) are located below the fixed frame (101) when the trolley (6) is in working position on the travelling crane (4).

The pot-tending module according to the invention provides the operator with good visibility on the electrolytic cell and on handling and working tools or devices during his work. It can also simplify the operator's task, particularly by avoiding large angular rotations with respect to his initial point. It also makes it possible to use the same module in separate electrolysis rooms in which the electrolytic cells are not all oriented in the same manner.

Another object of the invention is a pot tending unit (3) for a fused bath electrolysis aluminium production plant comprising a travelling crane (4) and at least one pot tending module (5) according to the invention.

Another object of the invention is the use of a pot tending module (5) or a pot tending unit (3)

according to the invention for doing work on electrolytic cells (2) designed for the production of aluminium by fused bath electrolysis.

Numeric marks

	1	Electrolysis room
	2	Electrolytic cell
	3	Pot tending unit
5	4	Travelling crane
	5	Pot tending module
	6	Trolley
	7	Shovel
	8	Crust breaking device
10	9	Anode handling system
	10	Hopper
	11	Control cab
	21	Anode
	22	Anode stem
15	30, 30'	Travelling crane rails
	100	Mechanical and electrical connecting device
	101	Fixed frame
	102	Hub
	103	Hub rotation axis
20	110	First rotating frame
	110'	First turret
	111	First annular bearing
	112	Second annular bearing
	113	First plurality of sliding and rotating
25		electrical contacts
	114	Second plurality of sliding and rotating
		electrical contacts
	1131, 1141	First members (called "external"
		members) of each electrical contact
30	1132, 1142	Second members (called "internal"
		members) of each electrical contact

	115, 116	Protective casings
	117	External electrical conductors
	118, 1181, 1182	Distribution conductors
	119	Distribution conductors
5	120	Second rotating frame
	120'	Second turret
	121	Sleeve
	122	Rotating joint body
	123	Rotation drive means
10	130	Axial cavity of the hub
	131, 132	Sealed rotating joints
	133, 134	Conduits
	140, 150	Drive motor
	141, 151	Gear
15	142	Toothed ring
	152	Toothed wheel
	153	Arm
	160, ..., 164	Complementary annular bearings
	170, 171	Complementary annular bearings